1. Header: **Generation and evaluation of long-term forecasts with NCEP Climate Model Forecast System: Predictability of ENSO and drought**
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NA08OAR4320912 Year 2 Progress Report 2010

2. Initiation year and planned duration: 05/01/2008 - 04/30/2011

3. Our goals are:
3.1 Develop a coupled data assimilation procedure for CFS;
3.2 Test the procedure for the modern era; use it for the past 150 years;
3.3 Perform retrospective forecasts for the past 150 years;
3.4 Assess model skills in NINO and drought forecast;
3.5 Design bias correction schemes for operational forecast.

4. Status, progress, and accomplishments:
4.1 Development and testing of the coupled data assimilation procedure for CFS (Wanqiu Wang and Hui Wang).
4.2 Gustavo Correa (LDEO), who joined the project on July/2009, was trained at NCEP, by Wanqiu Wang and Hui Wang, to setup and run CFS in SST assimilation mode.
4.3 A 150-year SST dataset (Hadley Centre + A. Kaplan) was converted to CFS format, and CFS was adjusted to handle historical data.
4.4 A 150-year control run with SST assimilation, was completed at NCEP.
4.5 A few sample forecast runs were carried out, for 1877-78,1982-83, and 1997-98 El Niños.
4.6 The model output was converted to NetCDF format, and posted on the LDEO data library for easy access and analysis:
http://kage.ldeo.columbia.edu:81/home/.OTHER/.gus/.cdfs/.NCEP/.CFS/.nc/

We have determined that:
A. Historic NINO events are properly represented in the 150-year control run (validation).
B. Retrospective forecast runs on El Niño years do reproduce the El Niño events, although broader and longer than the historic SST data indicates, which suggest that a model bias correction may be necessary.
C. Data deficiencies in the SST fields on high latitudes, perhaps enhanced by the interpolation scheme used, create problems in these non-target areas that are not prohibitive, but shall be fixed.

5. Publications and reports
5.1 Sarachik, E.S. and M.A. Cane, 2010: The El Nino-Southern Oscillation Phenomenon, Cambridge University Press, London. 384pp.
http://www.cambridge.org/catalogue/catalogue.asp?isbn=9780521847865&ss=cop
5.2 Chen, D., 2009: Coupled data assimilation for ENSO prediction. Advances in Geosciences, in press.

5.3 Cheng, Y., Y. Tang, X. Zhou, P. Jackson and D. Chen, 2009: Further analysis of singular vector and ENSO predictability in the Lamont model --- Part I: singular vector and control factors. Climate Dynamics, doi: 10.1007/s00382-009-0595-7. http://www.springerlink.com/content/p328671887136l08/fulltext.html
5.4 Cheng, Y., Y. Tang, P. Jackson, D. Chen, X. Zhou, and Z. Deng, 2009: Further analysis of singular vector and ENSO predictability in the Lamont model --- Part II: singular value and predictability. Climate Dynamics, doi: 10.1007/s00382-009-0728-z. http://www.springerlink.com/content/k5g37856j3t55r70/fulltext.html
5.5 Karnauskas, K.B., Seager, R., Kaplan, A., Kushnir, Y, Cane, M.A., 2009: Observed strengthening of the zonal sea surface temperature gradient across the equatorial Pacific ocean. J. Climate, 22, 4316-4321. http://ams.allenpress.com/perlserv/?request=getdocument&doi=10.1175%2F2009JCLI2936.1

Notes for Cane_NA08OAR4320912_2010.ppt

Top, left. Observed Sea Surface Temperature (SST) Anomalies in Dec-Feb (DJF) 1877-78 based on the Kaplan et al. SST reconstruction. *Top, right.* Retrospective forecast at a one-year lead (i.e. from January, 1877) of SST anomalies in DJF 1877-78. The forecast clearly predicts a very strong El Niño event one year ahead. (Recall that the exceptionally strong 1877-78 El Niño was associated with the loss of millions of lives in India, China, Ethiopia, Northeast Brazil and elsewhere; see Mike Davis, *Victorian Holocausts, El Niño Famines and the Making of the Third World*). The forecast appears too strong, especially at the coast, but the "observed" SST anomaly is likely to be underestimated because of the poor data coverage at that time.

Middle. As above but for DJF 1982-83. Forecast is from January 1982. This forecast SST anomaly is somewhat weaker than the observed, but correctly indicates a strong El Niño event.
Note that in both forecasts the SSTs in the remainder of the global ocean are, for the most part, of the correct sign but too strong.

Bottom, left. Precipitation over the Southwestern US (25N-40N, 95W-125W) 1856-2009 from observations (grey); the CFS SST-only assimilation (black); a 16-member ensemble of atmospheric CCM3 simulations with observed SSTs specified (blue line shows the mean; light blue shaded area indicates ±2 standard deviations about this mean). Since the CFS is only a single run close agreement is not expected; the shading is indicative of the expected spread if an ensemble of CFS runs were made. Nonetheless, some of the observed variability is captured, though the CFS variance appears greater than observed. *Bottom, right.* Surface temperature over the Southwestern US. As with precipitation, but with the CCM3 data indicated in red and pink instead of blue and light blue.

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